PAM & SAM System User's Manual

Part 5 - SAM Drive Technical Information

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This version replaces all previous versions of this document. It also replaces the SAM System Designer's Guide (1995-1996). Inmotion Technologies and ACC Motion have made every effort to insure this document is complete and accurate at the time of printing. In accordance with our policy of continuing product improvement, all data in this document is subject to change or correction without prior notice.

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Table of Contents

Table of Contents 3
List of Figures 4
List of Tables....4
Hardware Functional Description....5
Introduction....5
Power Board....5
Control Board 7
Brake Option Board....9
Specifications....11
Power Input and Output....11
Signal Inputs and Outputs 12
Environmental....13
Physical Characteristics 14
Dimensions....14

List of Figures

Figure 1 SAM Drive boards assembly....5
Figure 2 Power Board functional diagram....6
Figure 3 Control Board functional diagram....7
Figure 4 Brake Option Functional Diagram....10
Figure 5 SAM Drive Unit Dimensions....14

List of Tables

Table 1 SAM Drive Power input and output specifications....11
Table 2 SAM Drive Signal input and output specifications....12
Table 3 SAM Drive environmental specifications....13
Table 4 SAM Drive weight specifications....14

Hardware Functional Description

Introduction

Figure 1 shows the different assemblies that constitute a SAM Drive. The SAM Drive functional description is organized according to the functions performed by each board.

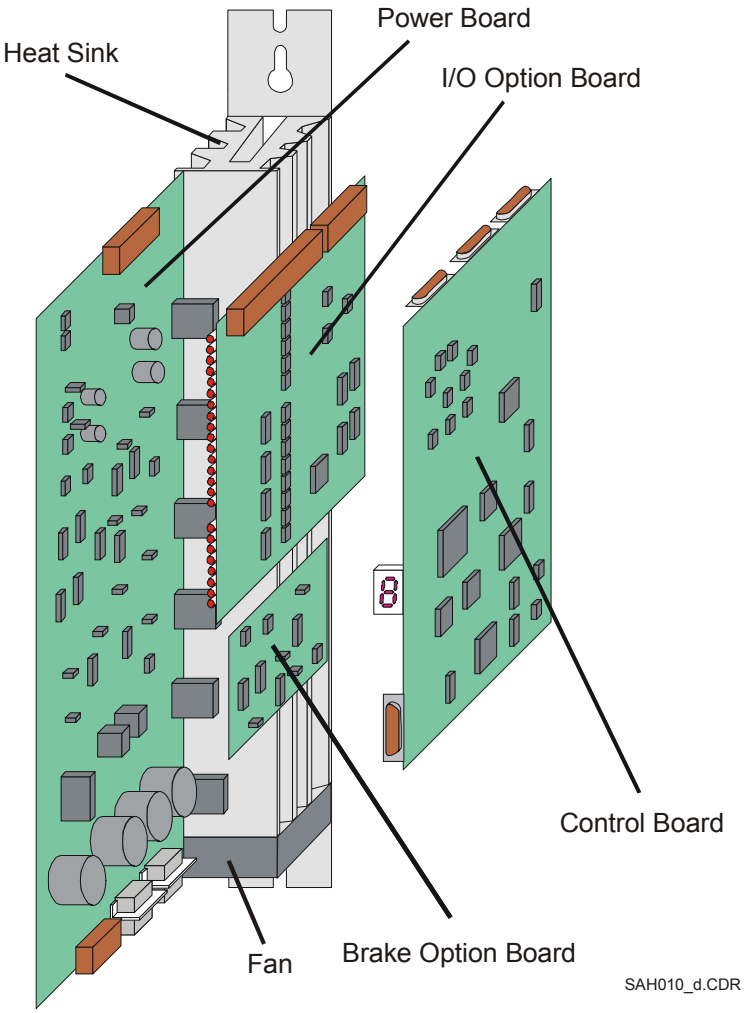


Figure 1 SAM Drive boards assembly

Power Board

General

Different Power Board designs are used for SAM Drives with different current ratings; however, the functional operation of all power boards is identical. Figure 2 shows a functional diagram of the Power Board.

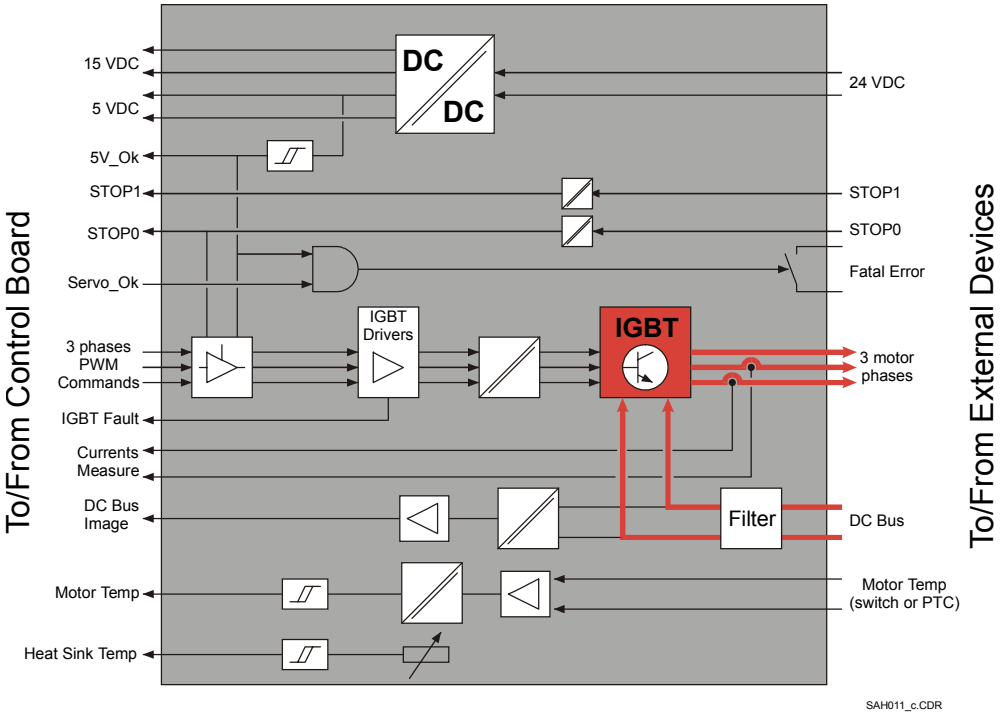


Figure 2 Power Board functional diagram

24 VDC

An isolated DC/DC converter produces all input voltages required internally by the SAM Drive from a single 24 VDC supply input. A voltage monitoring circuit detects over and undervoltage and supplies a 5V_OK status input to the control board. A 5VDC failure immediately disables the IGBT drivers.

User Stop0 and Stop1

The **USER STOP0** and **USER STOP1** inputs are buffered and transmitted to the control board. In addition, **USER STOP0** immediately disable the IGBT preamplifiers. For safety reasons they use “inverse logic”, which means that a zero voltage (no current) activates the corresponding Stop function.

For additional information, see "Safety and Protective Functions”.

Fatal Error

The **FATAL ERROR** contact is closed only when the internal 5VDC supply is available and no internal error condition exists. For additional information, see Part 3 - “Safety and Protective Functions”.

IGBT Output Converter

An efficient three-phase four-quadrant IGBT output converter powers the axis motor using DC power drawn from the DC Bus. During braking, kinetic energy is fed back to the DC Bus where it is available to other axes. Power components are mounted and thermally bonded to the heat sink. The heat sink mounting surface temperature is monitored and, together with a software based power stage thermal

model, used to provide a warning when the computed transistor temperature approaches the upper limit for reliable operation.

IGBT Fault

Sensors in the IGBT outputs measure motor current. Motor faults including phase to phase shorts and shorts to ground are automatically detected and result in immediate shutdown of the power stage by removing the current source to each IGBT pre-amplification circuit.

DC Bus

The DC Bus is filtered and supplies the IGBT final stage. An image of DC Bus voltage is transmitted to the control board. DC Bus voltage in excess of the allowable limit triggers an immediate shutdown of the power stage.

Motor Temperature

Motor temperature signal from either a switch or a PTC resistor in the motor is transmitted to the control board.

Control Board

General

Figure 3 shows a functional diagram of the Control Board. Different SAM Control Board designs are used depending on the position feedback option; however, the functional operation of all versions is identical.

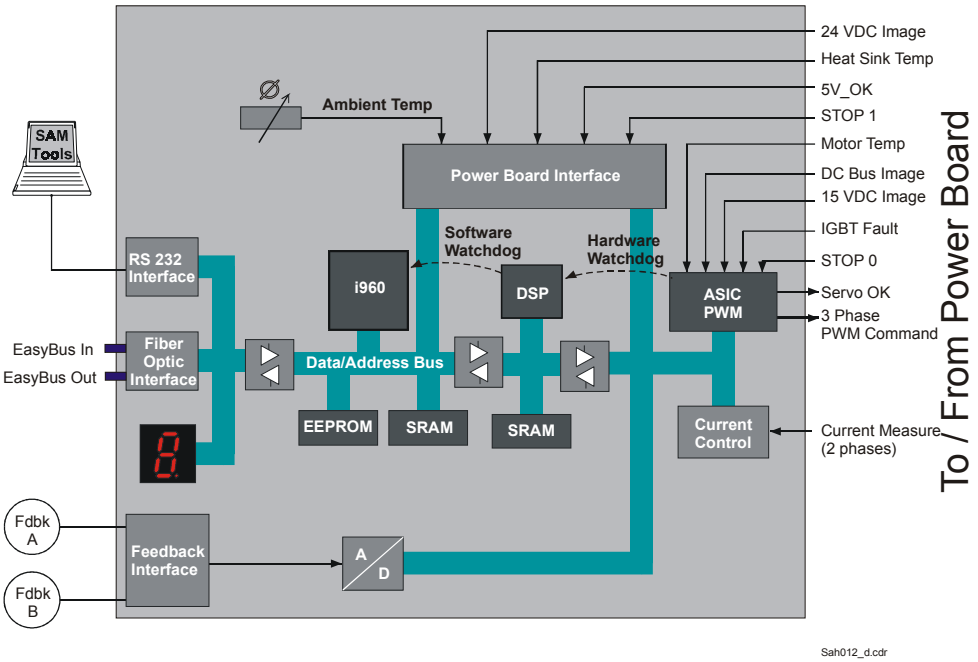


Figure 3 Control Board functional diagram

Most SAM Drive functions are managed by one of two microprocessors, an i960 RISC processor for high level control and a DSP for motor control. An ASIC

(Application Specific Integrated Circuit) generates PWM signals for the power board. PWM nominal frequency (8 kHz) can be adjusted to 4 kHz (higher output power and lower thermal losses, but lower pass-band and louder acoustic noise).

A compressed version of the SAM Drive operating software and application program along with uncompressed copies of a boot-up program, and all parameters are stored in non-volatile EEPROM. Upon power-up the boot-up program is copied into SRAM and executed. The boot-up program performs some hardware and communications initialization, then copies the operating software (decompressed) into SRAM.

Signals to/from Power Board

A warning (status bit) is set when 24VDC voltage approaches the lower limit for safe operation. Should the voltage continue decreasing (i.e. due to failure to stop the machine after a warning), the power stage is immediately shut down.

Heat Sink Temp inputs to a software-based power-stage thermal model that provides a warning when the computed transistor temperature approaches the upper limit for safe operation. Should the temperature continue increasing (i.e. due to failure to stop the machine after a warning), the power stage is immediately shut down.

Stop0 and IGBT Fault directly disable the PWM command signals

Undervoltage and overvoltage conditions on the +15 VDC internal supply are detected and activate a Stop0.

Motor Temp - derived from a thermal switch or PTC in the motor - initiates a Stop0, Stop1 or Stop2 depending on mask parameters defined by the user.

Temperature Sensor

A sensor monitors ambient temperature within the SAM Drive and provides a warning when ambient temperature is greater than the upper limit for safe operation. This can activate a STOP0, STOP1 or STOP2) depending on mask parameters.

RS-232 Interface

RS232 interface handles communication with SAM Tools for SAM Drive setup, testing and monitoring.

Fiber Optic Interface

The Fiber optic interface handles communication with the PAM over the EasyBus. Communication failures and errors are detected and can initiate a Stop (STOP0, STOP1, STOP2) depending on the setting of Mask parameters.

7 Segment Display

The 7 Segment display provides an indication of drive status and any existing error conditions. Refer to the PAM and SAM System End-User Manual (p/n 9032 011 933) for detailed display information.

Feedback Interface

The Feedback Interface provides the necessary hardware and software for interfacing to a SAM Drive any of the supported position feedback devices including:

- Resolvers
- Sine-cosine encoders
- Multi-turn sine-cosine encoders with absolute position readout

Each SAM Drive is supplied with one of two possible Feedback Interface configurations depending on the feedback option selected.

One option supports a single resolver; with the second option, two ports are provided. One port accepts a resolver. The second port accepts a high-resolution sine-cosine encoder or multi-turn sine-cosine encoder with ENDAT interface. User parameters inform the SAM Drive operating software about characteristics of the feedback device attached to the feedback port and the software configures the interface hardware as required.

For resolvers, the conversion process provides 1/185,000 turn (7 arc-second) resolution at speeds up to 8000 RPM with high dynamic performance. For sine-cosine encoders, the conversion process provides resolution of 1/3550 encoder period with total resolution dependent on the number of encoder periods per turn. A regulated, 4 wire, 5 VDC power source enables 5 VDC sine-cosine encoders to be operated over long feedback cables. The conversion software monitors the integrity of the feedback signals and problems such as loss of signal and excessive noise are detected and initiate a STOP0, STOP1 or STOP2 depending on mask parameters.

Brake Option Board

The Brake Option Board (see Figure 4) is used for controlling an electromechanical brake on a motor equipped with this option. The output is active (on) when the power stage is enabled, and the SAM DRIVE controls motor position. It is inactive (off) when the power stage is disabled for any reason (i.e. by command or STOP 0). To compensate for actuation time of an electromechanical brake, the brake option can be adjusted (by parameter) to turn off brake current a short time before the power stage is disabled.

The brake output is both open and short circuit protected. The condition of no current flowing (as would occur with an open brake circuit) is recognized and treated as an error condition. By default, a brake error bit generates a STOP0 (see "STOP 0").

This same Brake Option may be used to control the contactor in a motor short circuit braking circuit.

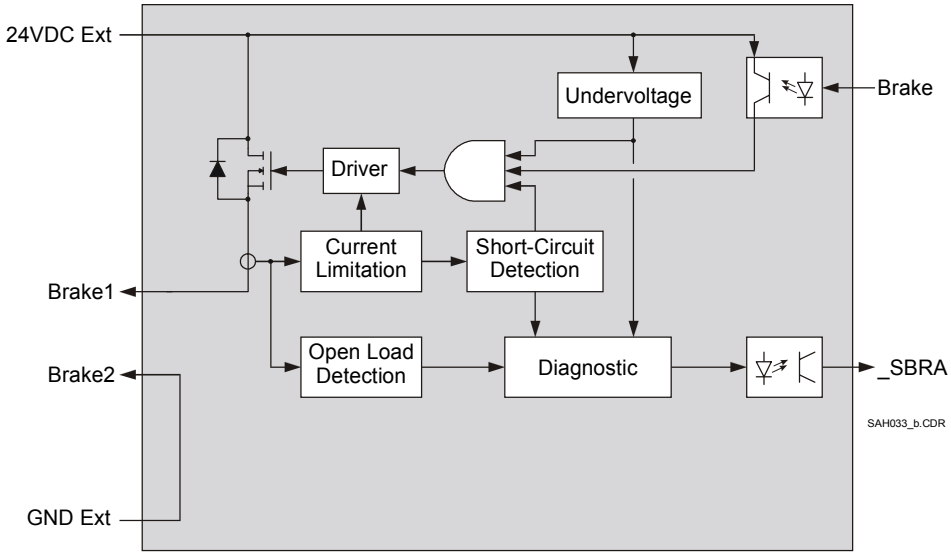


Figure 4 Brake Option Functional Diagram

Specifications

Power Input and Output

		SAM-DA-400							
		used at 400 VAC ± 10%				used at 480 VAC ± 10% (5)			
		07	14	28	50	07	14	28	50
DC Bus Voltage Input									
Nominal value	[V_{DC}]	570				680			
minimum value (1)	[V_{DC}]	0				0			
maximum value	[V_{DC}]	625				750			
Output Current (3) (6)									
I_{CONT} @ 4 kHz	[A_{RMS}]	8	15	28	58	7	15	24	56
I_{PEAK} @ 4 kHz (2)	[A_{RMS}]	13	34	49	84	12	33	46.5	79
I_{CONT} @ 8 kHz	[A_{RMS}]	6.5	15	20	34	6	15	16.5	30
I_{PEAK} @ 8 kHz (2)	[A_{RMS}]	10	28	38	62	8	26	34.8	56
Losses									
Base losses @ 0 amps	[W]	30	30	30	30	30	30	30	30
Add. losses @ I_{CONT} / 4 kHz	[W]	66	220	290	480	66	220	290	480
Add. losses @ I_{CONT} / 8 kHz	[W]	66	220	290	480	66	220	290	480
24 VDC Supply Input									
rated voltage	[V_{DC}]	24							
Tolerance	[V_{DC}]	19.2 - 30.0 (including all AC components)							
typical input current	[A]	0.8 (5)							
max. input current	[A]	1.0 (5)							
switch on current	[A]	2.5							

Note (1) Operation of a SAM Drive at DC Bus voltages down to zero VDC does not constitute an error. However, maximum achievable motor speed decreases with decreasing DC Bus voltage.

Note (2) All SAM Drives are capable of operating at peak current (I_{PEAK}) for at least two seconds. If the operating average (RMS) current is less than rated current (I_{CONT}) or the ambient temperature is less than max. permitted value, the overload condition is permitted for a much longer time. Thermal modeling performed by the SAM Drive provides full protection.

Note (3) @ 4 kHz and @ 8 kHz, refer to the PWM frequency selected. Operation at the 8 kHz PWM frequency with it's higher pass band and lower acoustic noise is recommended. In applications where lower pass band and a higher acoustic noise level are acceptable, the higher output power ratings at 4 kHz PWM frequency may permit selection of a smaller (and lower cost) drive. A SAM Drive's PWM frequency is user selectable by parameter.

Note (4) depends on the option(s) included in the unit

Note (5) SAM-DA-400 drives can operate at 400 or 480 VAC supply, provided that ProMotion 201 firmware is used. With previous firmware version, operation at 480 VAC is not allowed.

Table 1 SAM Drive Power input and output specifications

Signal Inputs and Outputs

		SAM-DA-400- (all models)
User digital Inputs & Safety Inputs		(standard and high speed user inputs) (STOP 0 & STOP 1 Safety inputs)
type		isolated 24 VDC input, type 2 (IEC1131-2)
V_{OFF}	[V_{DC}]	-0.3 - 5.0 @ 1 mA (max)
V_{ON}	[V_{DC}]	15 - 30 @ 10 mA (typ)
on-off and off-on delay	[ms]	0.3 (typical) for high speed input, 10.0 (typical) for other inputs
User Digital Outputs		
type		isolated 24 VDC output, protected against short-circuit, over-voltage and polarity reversal
I_{OFF} max	[mA]	0.4
I_{ON} max	[mA]	600 @ voltage drop = 2 V
on-off and off-on delay	[ms]	10.0 (typical)
User Analog Input		
type		differential input, 12 bit resolution
input range	volts	+/- 10.0
accuracy		+/- 2% of reading
input impedance	ohms	10,000
sampling rate	[kHz]	2.0
Brake Control (Option)		
type		isolated 24 VDC output; short-circuit, over-voltage and polarity reversal protected
I_{OFF}	[mA]	1
I_{ON}	[A_{DC}]	2.0 (rated), 2.4 (max) @ voltage drop = 2 V
Fatal Error		
type		floating contact, normally open, closed if no fatal error
max current	[A]	1.0
max voltage		60 VDC or 125 VAC
switch on/ switch off delay	[ms]	2.0 (typical)
Motor Overtemp		thermal switch or PTC
on/off transition	[Ω]	900 - 1800 (typ 1300)
hysteresis	[Ω]	100
Position Measurement Port A		See Part 2 - “System Design and Integration” for list of compatible position measurement devices
Position Measurement Port B		
Service Port		
type		RS-422 full duplex
baud rate	[baud]	19,200

Table 2 SAM Drive Signal input and output specifications

Environmental

	SAM-DA-400- (all models)
Protection	
protection degree	IP20 (IEC 529)
Ambient Temperature	
operating	5 - 40ºC, air temperature below unit
extended range	5 - 55ºC with derating of power outputs and forced air circulation within cubicle
daily avg. op. temp.	≤30ºC
transport and storage	-25...70ºC
Relative Humidity	
operating	5...95%, occasional condensation
transport and storage	5...95%, occasional condensation, except at low temperature in order to prevent the risk of damage by freezing.
Altitude	
operating	≤1000m
extended range	≤2000m with derating of power outputs and forced air circulation within cubicle
transport and storage	≤3000m
Climate	
pollution	degree 2
operating	Class B3 (IEC 654-1) /3K4 (721-3)
transport and storage	Class 2K4 (721-3)
Shock and Vibration	
high freq. vibrations	class V.H.4 (IEC 68-2-6), operating: 0.15mm constant amplitude (10□f□57) 2.0 g constant acceleration (57□f□150)
vibration severity	Class V.S.2 (IEC 68-2-6): ≤10mm/s
shocks	25 g / 10ms / XYZ, occasional (IEC 68-2-27), operating
free falls	1.0m / 5 times in 5 min. (IEC68-2-32), during transport

Table 3 SAM Drive environmental specifications

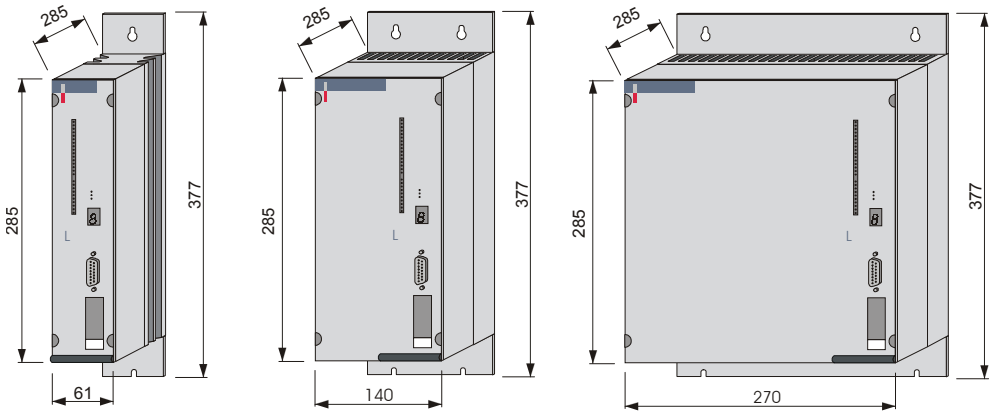
Physical Characteristics

		SAM-DA-400				
		04	07	14	28	50
Weight	[kg]	3.8	3.8	6.9	7.1	13.9

Table 4 SAM Drive weight specifications

Dimensions

Unit Dimensions - all Models



NOTE: Dimensions are in mm.

Figure 5 SAM Drive Unit Dimensions

For detailed mounting and interfacing dimensions see Part 2 - "System Design and Integration".